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EXAMINER

MILLS, G

ART UNIT

2106

PAPER NUMBER

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Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.
08/651,036

Applicant(s)
Owen et al.

Examiner
Gregory L. Mills

Group Art Unit
2106



☒ Responsive to communication(s) filed on 2/21/97

☐ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire three month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) 1-20 is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 1-20 is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☒ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been
☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 4 and 5

☐ Interview Summary, PTO-413

☒ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

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1. Applicant is advised that should claim 10 found allowable, claim 19 will be rejected under 35 U.S.C. 101 as being a substantial duplicate thereof. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to reject the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claims 10 and 19 are identical.

2. Claims 2-4, 9-12, and 14-20 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

“The metal layer” lacks antecedent basis in claim 2. Claim 1 refers to first and second *conductor* layers, and accordingly “at least one conductor layer” is suggested.

“The laser pulses” is indefinite in claims 3, 4, and 11. Claim 1 recites a first “at least one laser pulse” and a second distinct “at least one laser pulse”, and it is unclear if “the laser pulses” is intended to refer to both the first and second laser pulses, only the first at least one pulse (which could be plural pulses), only the second at least one pulse (which again could be plural pulses), or either the first or second at least one pulse. Applicant must amend the claims to clarify which was intended.

“The spatial spot size” should be “the first spatial spot size” in claim 4 for clarity.

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“The laser output” is indefinite in claims 10 and 19 because it is unclear if “the laser output” refers to the first laser output, the second laser output, either, or both. Applicant must amend the claims to clarify which was intended.

“The spatial spot size” is indefinite in claim 11 because it is unclear if “the spatial spot size” refers to the first spot size, the second spot size, either, or both. Applicant must amend the claims to clarify which was intended.

“A focal plane” is indefinite in claim 14. A focal plane of what? Amendment of claim 14 to read “the method of claim 1 wherein the first and second laser outputs are focused at a common focal plane, the method further comprising” is suggested. If this suggestion is adopted, “a focal plane” should then be changed to “the focal plane” at line 3 of claim 14.

“Modifying the spatial spot size” should be “modifying the second spatial spot size relative to the first spatial spot size” in claims 14 and 15 for clarity.

“The conductor and dielectric layers” is indefinite in claim 16 because it is unclear if “the conductor” refers to both of the first and second conductor layers recited in claim 1. Also in claim 16, “a second set of layers, including a second conductor layer” is indefinite because claim 1 already recites a second conductor layer, and it is unclear if “a second conductor layer” refers to the second conductor layer of claim 1 or is intended to refer to a different conductor layer. “To form a via through the first and second conductor and dielectric layers” is also indefinite in claim 16 because it implies that all the layers are drilled, which contradicts the specification in that the claimed method is directed to forming blind vias, so that at least one

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layer would not be drilled. Amendment of claim 16 to read "the method of claim 1 in which the first and second conductor layers and the dielectric layer form a first set of layers and the target comprises at least a second set of layers atop the first set including a third conductor layer and a second dielectric layer, the method further comprising repeating the steps ... to form a via through the third and first conductor layers and first and second dielectric layers" or something similar is suggested.

"The laser outputs" should be "the first and second laser outputs" in claim 18 for clarity.

"The method of claim 3" is indefinite in claim 19. As noted in section 1 above, claims 10 and 19 are identical. Apparently applicant intended claim 19 to depend from some claim other than 3, but it is unclear what claim that might be.

"Changing the output power" should be "changing the second output power relative to the first output power" in claim 20 for clarity.

"The output of a lamp" lacks antecedent basis in claim 20. "An output of a lamp" is suggested.

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

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4. Claims 1-3, 9, 10, 12, 13, and 19 are rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent 4,789,770 to Kasner et al.

Referring to Figures 3-5, Kasner discloses a method for laser machining a depthwise self limiting blind via (18) in a multilayer target (10) including first (11) and second (23) conductor layers and a dielectric layer (26) having respective ablation energy thresholds as claimed including generating a first laser output (57) containing at least one laser pulse having a first energy density over a first spatial spot size, the first energy density being greater than the first conductor ablation energy threshold (col. 6, lines 50-55), applying the first laser output to the target to remove the first conductor layer within a first spot area of the target (col. 8, lines 18-20), generating a second layer output (56) containing at least one laser pulse having a second energy density over a second spatial spot size, the second energy density being less than the first and second conductor ablation thresholds (col. 7, lines 39-41) and greater than the dielectric ablation energy threshold (col. 6, lines 35-40), and applying the second laser output to the target to remove the dielectric layer within a second spot area of the target (col. 8, lines 25-30), leaving the second conductor layer unvaporized and forming a depthwise self-limiting blind via.

The dielectric material is glass-reinforced epoxy, for example (col. 5, lines 10-30) and the conductor layers are copper (col. 4, line 65). Some of the laser pulses have wavelengths of 400 nm (col. 6, line 57). The first spatial spot size is about 38 microns (col. 7, line 66). Some of the laser outputs are generated by a solid-state Nd:YAG laser (col. 8, line 17). The target is a circuit board (col. 4, line 63).

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5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

6. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kasner as applied to claims 1-3, 9, 10, 12, 13, and 19 above, and further in view of LaserPulse, Fall 1993 issue.

As applied in section 4 above, Kasner discloses the invention substantially as claimed, but does not show the recited processing parameters.

Referring to page 6, "UV Laser Micromachining Applications Continue to Grow" and the unnumbered page entitled "4420 Laser Micromachining System", the LaserPulse newsletter shows that it is known in the art to laser drill circuit board materials using laser pulses with temporal pulse widths shorter than 100 ns, average output powers of greater than 100 mW, and pulse repetition rates greater than 1kHz (see the specs for laser model 4575). The LaserPulse newsletter teaches that these parameters provide low thermal damage, precision depth control, and the ability to machine various materials (see page 6). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use laser pulses with temporal pulse

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widths shorter than 100 ns, average output powers of greater than 100 mW, and pulse repetition rates greater than 1kHz as the process parameters in Kasner to provide low thermal damage and precision depth control as taught by the LaserPulse newsletter.

7. Claims 5-8, 14, 15, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kasner as applied to claims 1-3, 9, 10, 12, 13, and 19 above, and further in view of U.S. Patent 5,073,687 to Inagawa et al.

As applied in section 4 above, Kasner discloses the invention substantially as claimed, but does not show generating the first laser output so that it has a power greater than the power of the second laser output.

Referring to Figures 1-3, Inagawa shows that it is known in the art to laser drill a multi-level circuit board by generating a first laser output (R_1) of relatively high power (P_1) and applying the first output to a target area to remove a metal layer (1a), and then generating a second laser output (R_2, R_3) of relatively low power (P_2-P_5) and applying the second laser output to the target area to remove a dielectric layer (1b). The power is changed by changing the output of a pumping source (14). The process allows a circuit board to be drilled using a single laser without any adverse thermal damage to the dielectric layer (col. 5, lines 35-42). It would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the dual laser system of Kasner with a single laser and to generate a first laser output with larger power and a second laser output with smaller power by changing an output of a lamp pump

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source to reduce the cost of the system and form a blind via with minimal thermal damage to the dielectric layer as shown by Inagawa.

Regarding claims 7, 8, 14, and 15, although Inagawa shows changing the energy incident on the target area (i.e., the energy density) by changing the power output of the laser, it would have been equally obvious to one of ordinary skill in the art at the time the invention was made to change the energy density by changing the spot size of the laser upon the target area since the examiner takes Official Notice of the equivalence of the step of changing a laser's output power and the step of changing a spot size for their use in the laser machining art and the selection of any of these known equivalents to change the energy density provided on a target surface would be within the level of ordinary skill in the art. In re Fout, 213 USPQ 532 (CCPA 1982). This equivalence may be shown by the equation: $E_d = (P/A) * t$, where E_d is the energy density, P is the beam power, A is the area of the beam spot on the workpiece, and t is the pulse length. The energy density may clearly be set to a desired value by changing either the power or the spot size.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to change the spot size either through using a variable focus lens or by moving the workpiece, both methods being notoriously old and well-known in the art for the purpose of adjusting a laser spot size on a workpiece, to conveniently achieve a required change in size.

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8. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kasner as applied to claims 1-3, 9, 10, 12, 13, and 19 above, and further in view of Soviet patent publication 1750900 to Arkhipenko et al.

As applied in section 4 above, Kasner discloses the invention substantially as claimed, but does not show directing laser pulses sequentially to multiple positions defining a contiguous set of areas extending outwardly from a central portion along a path to the periphery of a spatial region.

Referring to the abstract and sole Figure, Arkhipenko shows that it is known in the art to form blind vias by directing a laser beam sequentially to multiple positions defining a contiguous set of areas extending outwardly from a central portion along a path to the periphery of a spatial region ("scan [the] laser cutting beam in [a] series of concentric circles of increasing diameter"). Arkhipenko teaches that this allows laser drilling of blind vias of large diameter in printed circuit boards. It would have been obvious to one of ordinary skill in the art at the time the invention was made to direct the laser pulses of Kasner sequentially to multiple positions defining a contiguous set of areas extending outwardly from a central portion along a path to the periphery of a spatial region to enable the formation of relatively large blind vias as taught by Arkhipenko.

9. Claims 16 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kasner as applied to claims 1-3, 9, 10, 12, 13, and 19 above, and further in view of U.S.

Patent 5,227,013 to Kumar.

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As applied in section 4 above, Kasner discloses the invention substantially as claimed, including a target comprised of two dielectric layers and at least three metal layers (Fig. 2), but does not show repeating the disclosed process to produce a stepped via as claimed.

Referring to Figure 6, Kumar shows that it is known in the art to laser drill stepped vias in printed circuit boards. It would have been obvious to one of ordinary skill in the art at the time the invention was made to merely repeat the steps of Kasner and form a stepped via to produce a desired circuit board configuration as illustrated by Kumar.

10. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kasner as applied to claims 1-3, 9, 10, 12, 13, and 19 above, and further in view of Harris et al., "MCM Micromachining: Nd:YAG UV Laser Process is a New Option".


As applied in section 4 above, Kasner discloses the invention substantially as claimed, but does not disclose producing non-circular vias.

Referring to the Figure labeled "No Masks Needed", Harris shows that it is known in the art to laser drill non-circular vias. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use Kasner's process to form a non-circular via to produce a desired circuit board configuration as illustrated by Harris.

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11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Davis, Leary-Renick, Arai, Wai, Owen, Bachmann, and Martyniuk show laser drilling blind vias. Takahashi shows changing energy density by changing a spot size.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Gregory Mills whose telephone number is (703) 308-1633. Faxes may be sent to Group 2100 at (703) 305-3431 or (703) 305-3432



Gregory Mills
Patent Examiner
Art Unit 2106

April 4, 1997